UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 797

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. ▼ November 22, 1919

COMMERCIAL DUTCH-BULB CULTURE IN THE UNITED STATES

By

DAVID GRIFFITHS, Agriculturist, Office of Horticultural and Pomological Investigations, and H. E. JUENEMANN, Superintendent of the Bellingham Plant-Introduction Field Station Office of Foreign Seed and Plant Introduction

CONTENTS

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CONTENTS.

BULB PRODUCTION IN THE UNITED STATES.

The production of bulbs in the United States is in its infancy. In normal times the value of the bulbs used in this country is not far from $2,000,000 a year, while those actually produced here are scarcely worth $25,000 in any one year.

This condition exists in spite of the fact that it has been known for generations that narcissus bulbs of perfect quality can be grown over a wide latitude and that tulips, although more exacting in their requirements, can also be produced successfully. Those best informed are just as sanguine about the production of hyacinth bulbs,

but, true to their scientific training, they are inclined to withhold advice and judgment because, so far as is known, no actual demonstration has yet been successfully accomplished on a scale large enough to command respect. The reason for this can be summed up in the phrase "We have thought that all of these stocks could be bought cheaper than we could grow them." Whatever may be the truth regarding this prevalent opinion, whatever may have been the facts in the past, it is very certain that in the future the conditions are going to be different. The dissemination of such information on the subject as is available at this time is therefore pertinent.

In this brief bulletin details have been largely eliminated. The various methods of bulb culture are described, with little attempt to discriminate between them. As American experience is not extended enough to have crystallized into general practices, it is consequently considered advisable to present those methods which have succeeded in this country and abroad. Variations in practice will be inevitable as an industry in bulb production is developed in this country.

Thus far, the commercial production of Dutch bulbs has in this country been confined mainly to the Atlantic and Pacific seaboards, in the former north of Norfolk and in the latter north of San Francisco. The available data are more or less meager in either case, but good bulbs have been produced in both regions.

The western bulb area appears to be rather narrow, being confined to a strip of territory which receives suitable rainfall and is sufficiently affected by seacoast conditions to prevent rapid transition from winter to summer.

The eastern area is much more indefinite as to width, as the heat and moisture conditions are not so sharply defined. In the interior, in the Ohio and Mississippi Valleys, small quantities of tulip and narcissus bulbs have been grown sufficiently long to show the possibility of the successful production of many varieties.

Some of the hardier and more robust of the narcissus varieties thrive well and naturalize even in the Gulf States, but this region is best adapted to the so-called South France stocks. The growing of tulips and Dutch hyacinths probably should not be attempted there.

Contrary to what would be generally supposed, it is not too cold for tulips and narcissi to succeed as far north as Sitka, Alaska. They thrive well along the entire northern border of the United States wherever the moisture conditions are suitable.

From the above it will be seen that these stocks succeed under a great diversity of conditions. Indeed, they seem to be as adaptable as ordinary cultivated crops.

The successes with the three main groups of these bulbs on the northern Pacific coast; the large production of a long list of narcissus

varieties in southern Illinois and Virginia; the culture of Darwin and other tulips in Michigan, northern New York, Ontario, and Virginia, and the admirable hyacinth bulbs often produced in private gardens throughout the region south of New York, under conditions of comparative neglect and a large measure of ignorance of their life history, would seem to prove sufficiently that we have an abundant territory adapted to growing these stocks.

SOIL ADAPTATION.

The culture of bulbs is associated in the public mind with sandy soil, and the preponderance of advice as to their handling specifies sandy soils as preferable to any other. Periodical literature especially is full of reference to the so-called "sand-dune bulb fields" of the Netherlands. Abundant evidence is at hand to show that purchasers of bulbs have good success in flowering them on almost any soil which is available, and though this is a very different matter from producing the bulbs with flowers in them it is nevertheless a proof of the wide adaptability of these stocks.

In the experiments at Bellingham, Wash., thus far, better tulips and better narcissus bulbs have been produced on silty soil than upon the lighter sandy soils. The trials with hyacinths are not decisive; indeed, other factors may account for the results. Proper fertility has not always been maintained, and the heavier soils are less exhausted by long cropping. While this may be true, the fact stands out prominently that the production of tulip, narcissus, and even hyacinth bulbs of good quality can be accomplished on silt-loam soils underlain by clay at a depth of 16 inches. On the other hand, it should be realized that the ability to produce bulbs at a profit will be the controlling factor, and the expense is much less on light than on heavy soils.

When all is said, few plants are more widely adaptable and few crops more easily grown than bulbs. The regions in this country are few and small, indeed, where some varieties of each of the three groups are not successful when grown for ornamentation, and the possibility of the production of bulb crops is promising. The flowering of the bulbs, as we know, is accomplished in a great variety of media, almost anything, from water to ordinary loam soils, answering the purpose provided the atmospheric conditions are suitable.

Mechanics probably has more to do with the suitability of sandy soil than any inherent preference of the bulbs for sand rather than for heavier loam. It is possible that it will be cheaper to add heavy applications of fertilizer than to handle the bulbs in heavy soils. On the other hand, many varieties will coat up better on light

than on heavy soils. The character of the bulbs grown on heavy and on light soils will vary somewhat, of course, as it will with shallow and with deep planting. The indications are that success can be secured in bulb production on a friable loam soil, whether it has a preponderance of sand in its composition or not.

TEMPERATURE, SOIL, AND FERTILITY REQUIREMENTS.

We may gain a valuable lesson as to the requirements and suitability of these bulbs from the long private experiences of those who have flowered them either in pots or in borders in different regions and then tried to carry on their propagation. It is the common experience that these stocks gradually deteriorate in size in the hands of the small grower. This is not always a proof of lack of adaptability, because it is seldom that the stocks are properly handled. They become overgrown with weeds, are left undug too long, or are improperly fertilized.

About 40 miles from the coast in northern California we have a record of an apparent intelligent handling of Darwin tulips over a period of years. Here, with good fertility and proper handling, the bulbs gradually deteriorate in size. Two natural conditions in this locality seem to be accountable. The moisture is likely to fail suddenly before the plants complete their growth, and the temperatures are likely to run suddenly high at the same time, thus shortening the growing period suddenly. Such conditions are evidently not suited to commercial bulb production.

The consensus of experience in the vicinity of the District of Columbia probably would be very similar to that in the interior region of northern California—the bulbs gradually deteriorate in size. In this region, however, the average soil is naturally poor, which, coupled with imperfect growing of small lots, is responsible for much of the failure. There has been recently ample proof that all of the robust varieties of both the nacissus and the tulip can be successfully produced in good quality even here. It is not to be considered, however, that the conditions are by any means ideal. The main adverse condition, aside from natural lack of soil fertility, is the high temperatures, which are normal for May and June and occasionally occur even in April. There is also an uncertainty regarding moisture supply before the end of the growing season.

Suitable temperature, moisture, and soil conditions obtain in both our Atlantic and Pacific coast regions. In the interior of the eastern United States, as far west as Illinois and Michigan at least, conditions are favorable enough for success. The temperature is not as favorable as in the cooler coastal climate, but, in our opinion, where friable well-drained soils occur the conditions are generally as satis-

factory for the production of Dutch bulbs as for the common staple crops usually grown there.

The fertilizer requirement of bulbs is not sufficiently appreciated in this country. These stocks require heavy fertility to produce well and to maintain their size. We have sometimes thought that the better success with narcissus than with other bulbs is due to the fact that this group requires less fertility and is exceedingly impatient of any soil loaded up with organic matter, even when well incorporated. This does not mean that the narcissus requires a lean soil, but that a heavily fertilized soil must not be in contact with the bulb.

The practice of rotation by the bulb grower on the other side of the Atlantic is in this particular instructive. The formula of the rotation may be stated as follows: A heavy application of cow manure in winter, followed by a crop of potatoes dug early and followed by hyacinths one year, tulips the second year, and then narcissi. When the latter are left in for two years they commonly receive a top-dressing of manure the second year. The soil in which the narcissus is planted in this rotation has produced a crop of potatoes, one of hyacinths, and one of tulips. The application of a mulch of manure always works well with the narcissus, because the fertility is secured in the form of leachings. The relative fertility requirements of the bulbs are well exemplified in this rotation.

NUMBER OF BULBS GROWN PER ACRE.

A practical bulb grower will almost invariably shy at a question relating to the number of Dutch bulbs that can be grown on a definite area of ground, especially if the exactitude of the Dutch method be followed. The reason is apparent if we stop to reflect.

Let us analyze an acre's planting on the Dutch plan. Allowing for one 10-foot roadway and the necessary waste on the sides, there is room on an acre for 48 beds with paths 1 foot wide. The length of these beds when the necessary crosswalks are taken out will be not more than 190 feet. If the rows are 6 inches apart 18,240 rows will be planted. Then if 7 bulbs are planted to the row, an acre will be fully occupied by 127,680 bulbs. On the other hand, if 50 bulblets to the row are planted it will take 912,000 to occupy the acre. In round numbers, therefore, the number grown on an acre will range from 125,000 to 900,000, a very wide variation. In practice, the grower may have 20 beds 50 feet long of one variety, and if he sizes his bulbs closely he will plant in those 20 beds, about one-forty-fifth of an acre, 7, 9, 11, 14, 21, 35, and 50 bulbs to the row. It is manifestly very difficult to say how many bulbs can be grown on an acre. The matter is still more complicated by the constant fluctua-

tion in the relation of different sizes, owing to seasonal variation, and, further, by the fact that merchantable bulbs are turned off more closely some seasons than others. In the above case an average, which means but little, would be 8,400 for the area specified. It is on this account that the row and the bed are such prominent units of bulb measurement in the Netherlands. They do not contain the same number of bulbs, but an effort is made to occupy the ground uniformly, and there is consequently about an equivalent quantity of plant material on any given area.

PLANTING.

Long experience and practice have brought the art of planting, as well as other Dutch-bulb operations, to an exact formula. In this country the ground is thoroughly prepared with a plow, disk, and harrow, but in the Netherlands mainly with a spade and rake. It is well to run a float or roller over the field as a final preparation, in order to smooth the surface and compact the soil a little.

FIG. 1.—A field of the Sir Watkin narcissus. Experimental planting at Bellingham, Wash., 1918.

The land is first laid out into plats accurately measured and squared with the aid of a taut line. These plats are then subdivided into beds by means of lines stretched on each side of the 3-foot bed,[1] leaving, with us, a 15-inch path between. (Fig. 1.) At the same time a permanent peg or stake is set at each corner of the bed. These stakes remain throughout the season. The bed is then marked off with a common spade by shoving it into the ground along the line to a depth of 5 or 6 inches and pulling the dirt into the center of the bed by a scraping motion. The soil is then, with a shovel, thrown out of the first bed in the plat to a depth of about 4 inches. Next, the bottom of the bed is smoothed with a garden rake, and a marker is run through, which defines the boundaries, rows, and the center of the planted bed. After this, the bulbs are set out, usually by two men on their knees on either side of the bed. The covering is

[1] While the beds are laid off 3 feet wide and are spoken of as 3-foot beds, bulbs are set on the 3-foot line on either side. The bed, therefore, really occupies about 39 inches, since the plants on the edges project 1½ inches on either side, thus making the bed a meter wide, the same as the conventional Dutch planting.

accomplished when the dirt is taken out in opening the second bed, the surface being left rough as the dirt falls from the shovel and smoothed off late in the season. The bottom of the second bed is then prepared for setting the bulbs, and the process is repeated with successive beds until the entire plat is planted. To facilitate the work the corners of the beds are marked permanently by stakes at the time they are laid off and these stakes serve as guides.

In laying off the ground careful attention is given to configuration, so that the drainage may be as nearly perfect as possible. Commonly the plats are marked off by the previous plowing, the back furrow being thrown into the middle of the land, thus draining into the dead furrow between the plats or lands. Where the subsoil is sandy, allowing the ready percolation of moisture, drainage ditches between the plats are not necessary, but in heavier soils it is imperative to make them. Even in sandy soils it is better that ample drainage be provided, because if the surface of the soil freezes there may be a time when water will be pocketed for a few days, to the injury of the bulbs.

FIG. 2.—Marking a bed with a homemade marker. The machine marks the rows, the outside, and the middle of the bed.

The bulb bed in the Netherlands is laid off a meter wide and of any convenient length—the width of the plat or land—preferably about 33 feet (10 meters). The plats are separated by walks 4 to 8 or 10 feet wide, which include the drainage ditches. In some instances narrow and wide walks alternate. Between the beds paths 12 to 16 inches wide are left. The rows run across the beds and are therefore a meter (39.37 inches) long. Our marker was made to lay off rows 6 inches apart. This marker is the same in principle as that used by the onion growers of southern Texas, being made of slats set in the periphery of an 18-inch cylinder 3 feet in length (fig. 2).

This handmade machine marks the row and the boundaries and center of the bed and is operated in the depression, which has previously been raked to a level. One marker does all the work, and

all rows are therefore 6 inches apart. The only variation occurs in the number of bulbs set in the row. Large bulbs are set 7 to the row; the second size, 9 to the row; and the third, 11 to the row. (Fig. 3.) These are commonly set upright and one in a place. The fourth size is planted 14 to the row, seven clusters, or hills, of two each, the bulbs being placed close together in any position in which they happen to fall. The fifth size is planted 21 to the row, seven clusters, or hills, of three each, the bulbs lying in any position. The sixth size is planted like the last—five in each of seven clusters or hills. Still smaller sizes are strung along about 50 to a row without any attempt at clustering. In practice, the number of bulbs of the last two sizes is only approximate, no attempt being made to count them. In the case of very large bulbs of hyacinths or of the Emperor narcissus, which can not be planted without crowding seven to a 6-inch row, a deviation is made in the spacing and the bulbs are set on the mark and half way between, making the rows 9 inches apart. Occasionally, smaller sizes of bulbs are strewn broadcast on the bed. This method, while simplifying the planting, makes digging much more difficult, for, instead of following each row across the bed with the digging tool, the operator must turn all the soil in the bed over to a sufficient depth to insure not cutting the bulbs and then must pick them out by hand.

FIG. 3.—Planting bulbs with a small crew.

This slightly modified Dutch method has not been much followed in this country except on the Pacific coast, and there it has recently been abandoned at Eureka, Calif., by Mr. Ward, who is experimenting with methods thought to be better adapted to the use of machinery. The bulbs there are set 2 inches apart in 2-foot rows.

In the Virginia bulb region (and a similar practice is followed generally on the northern Atlantic coast) the bulb beds are opened by turning furrows in opposite directions with a 12-inch plow. The dead furrow thus made is worked to a level with a cultivator, making a 15-inch bed, the path between being the same width as the bed. This is said to be similar to the Guernsey method. The bulbs are

covered either with the plow or with a winged cultivator which throws the dirt from the back furrow in either direction on the beds of set bulbs.

In the South Atlantic region bulbs are planted usually in 15-inch rows, the rows being opened with a 1-shovel winged cultivator. The bulbs are then set 2 or 3 inches apart and then covered by running a harrow over the ground. It is said that during the past two or three years an innovation has been introduced in some places in the Netherlands where a special 10-inch moldboard plow, having a triangular extension downward and outward, makes a depression the entire length of the furrow slice. The bulbs are set in this and the next bout covers the first row and opens another 10 inches from it.

DEPTH OF PLANTING.

About the first question asked by the novice relates to the depth of setting bulbs used in decorative planting. English writers dwell on

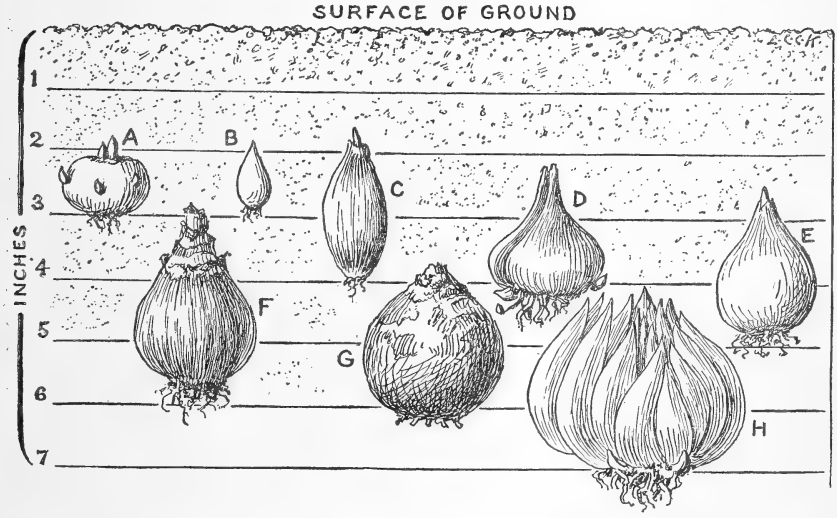

FIG. 4.—Sketch showing the proper depth to plant various kinds of bulbs: *A*, Crocus; *B*, snowdrop; *C*, iris; *D*, gladiolus; *E*, tulip; *F*, narcissus; *G*, hyacinth; *H*, lily.

this point and are explicit in their instructions. The accompanying diagram[1] (fig. 4) is a useful guide in planting bulbs for decoration. A common rule is to set the bulbs at a depth $2\frac{1}{2}$ times their diameter. Such a rule, while useful to the novice, will be little followed by one having experience with bulbs. He will know by intuition and will vary the depth with varying conditions. He will set his bulbs deeper in light than in heavy soil and in exposed than protected places. He will also set bulbs deeper in ground which heaves badly than in soil

[1] Adapted from Wight's Pictorial Practical Bulb Growing.

which has more humus in its composition. Likewise, the intended application of litter later in the season will influence the depth of planting.

In fact, the depth at which bulbs are set in commercial and decorative plantings is far from what occurs in nature, and they thrive at many varying depths. The point is emphasized in the case of many tulips which drop down 2 to 4 inches below the 4-inch level at which they are planted. It is not uncommon with us to have crocuses and tulips which are missed in the field come up the next season from a depth of 10 inches and flower perfectly. Indeed, there are indications that a great deal is still to be learned about the depth of planting, especially of tulips. There are accounts of tulips in Italy which have flowered perfectly for 12 to 15 years when planted a foot deep. There appears to be a correlation between deep planting and the permanent performance of tulips which are not shifted annually.

FIG. 5.—Removing the flowers before the petals fall in order to prevent seed production and the spread of the fire disease.

TREATMENT AFTER FLOWERING.

Little attention need be given to narcissus bulbs after flowering except that for the best results they should be kept free of weeds, like all other crops. With hyacinths and tulips, however, the matter is different. Here, it is necessary to remove the flowers, for the reason that there is an abundant seed production, which if allowed to develop would be at the expense of bulb growth. Again, with tulips it is imperative under certain conditions that no flower parts be allowed to fall upon the beds. Under seacoast conditions of humid atmosphere and heavy precipitation during the flowering season and immediately thereafter, the presence of fallen petals is very conducive to the development of the fungus Botrytis, the cause of the fire disease. It is therefore necessary in such situations to remove the flowers (fig. 5) before the petals fall. In varieties of narcissus which produce seed in abundance the removal of the flowers is, of course, advantageous.

ROGUING.

In the process of handling bulbs, mixtures are certain to take place to a greater or less degree. The laborer may be careless, or a bulb

may roll off of one tray into another, or when bulbs follow bulbs in the rotation the ones accidentally missed in digging and the droppers to a large extent may come up in subsequent years, all producing a mixture of varieties. To prevent these so-called "rogues" attention must be given at the time of flowering and they must be dug out. Were it not for the necessity of roguing when the flowers are fully open, other practices could be carried on in commercial work, such as cutting the flowers in the bud or not allowing them to open at all, and this would probably be a benefit to bulb production. However, in our work and in commercial work as well, certain benefits accrue in public appreciation which amply repay one for leaving the flowers until they begin to fade. This also allows the study and comparison of the different varieties, which in the rapid changes which take place in the relative merits of stocks due to constant improvement is all but imperative.

HARVESTING THE FLOWERS.

When there is a market for cut flowers from commercial bulb growing this is an added revenue. Indeed, in the Virginia bulb section the cut flower is the most profitable end of the business, and bulb production is purely secondary. The method of cutting the flowers is important. In the Virginia fields, where the stems of the narcissus, owing to the rather sudden advent of spring with attendant comparatively high temperatures, are short, the flower stem is pulled in gathering the flowers. In regions where the springs are cooler and the stems produced are longer they can be cut to better advantage, and this method is better for the bulb crop. In harvesting flowers from tulips, care must be taken not to rob the bulb of its leafage. In most sections it is not practicable to harvest tulip flowers for sale, except to a limited extent from the robust late varieties which have a foot or more of stem above the upper leaf. In removing tulip flowers after they have faded no leafage is destroyed, only the flower and 2 or 3 inches of stem being removed. The hyacinth spike of flowers is removed by severing the scape, or stem, with a knife.

There is a possibility that a by-product in the form of an essential oil may be made an added source of revenue here.

CULTIVATION.

There is no uniformity of practice in cultivating Dutch bulbs in this country. In the Netherlands the hoe and the hand serve every purpose after the plants appear above ground. The hoe for the paths and hand weeding for the beds are universal practices. It is difficult to use a tool in plantings of bulbs only 6 inches apart. In

the work at Bellingham, Wash., however, both a narrow-bladed hoe and a 3-tined hoe have been used with good success, the latter while the weeds are small and the former afterwards.

At Bellingham the beds are left rough at planting time. They are covered by the dirt as it falls from the shovel and are left untouched until the planting is finished, when the cultivation is begun by raking the beds smooth with a hand rake. This raking is kept up as soil conditions permit until the appearance of the plants above ground prevents it. After this, practically no cultivation is attempted, but hand weeding is practiced and the paths between the beds are kept free from weeds by the use of the hand or wheel hoe. Before digging,

FIG. 6.—Covering bulb beds in the Virginia region in late autumn with a plow.

the beds are hoed off to get rid of the old leaves as well as the remaining weeds. This practice is not satisfactory and is particularly expensive.

In the fields in Virginia, where bulbs are grown in beds 18 inches wide with 18-inch walks between, the practice is not essentially different from that at Bellingham, but there the bulbs are not dug more often than once in three years. In autumn and early winter in that locality the beds are covered by turning a furrow each way from the paths, thus covering them with 3 or 4 inches of soil. (Fig. 6.) Before the plants begin to push through in the spring the beds are gone over thoroughly with a spike-tooth harrow. After the tops die down the weeds are kept mowed and allowed to lie on the ground.

In the South, both horse and hand cultivation have been practiced, the bulbs being planted in rows 15 inches apart. There is little doubt that a method of planting and digging which will make possible the keeping down of weeds by some power other than the hand will prove decidedly advantageous. It is essential to get away from the practices of letting the weeds go after the plants are up, on the one hand, and of hand weeding after the plants are up, on the other.

FIG. 7.—Digging bulbs.

HARVESTING THE BULBS.

Harvesting the crop of bulbs is another rather tedious operation. (Fig. 7.) Thus far in the investigations of the Department of Agriculture this harvesting has been purely handwork. The operator works on his knees with a light, short-handled spade. In the Netherlands a flat hand trowel is used, a tool which is not serviceable in our heavier soils. The proficient workman operates this with one hand and throws out the bulbs with the other, while the novice requires both hands in using the tool, letting go with one to pick up the bulbs. A day's work in our silty soils consists on an average of about four 50-foot beds a day, and 50 to 75 per cent more on loose sandy soils. Tulip bulbs are put into small trays, which are shoved along the ground as the bed is dug. These are emptied into baskets or directly upon screen shakers (fig. 8), which sift out the greater part of the dirt. The bulbs are then transferred to the bulb house. Narcissi and hyacinths, except the smaller sizes, are dug like tulips, thrown into rows between the beds, and transferred to the bulb house later. The time allowed them to dry in this way will depend

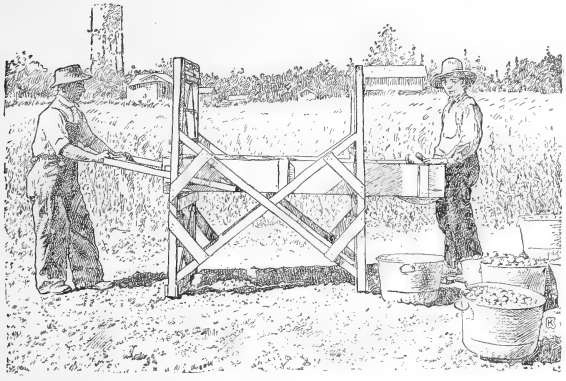

FIG. 8.—A homemade shaker used to remove loose dirt from the bulbs after digging.

on the moisture present and the effect of the sun on the bulbs. Some varieties, and young bulbs especially, burn in a few hours and consequently must not be left exposed for any length of time.

In the Virginia fields the narcissus bulbs are plowed out, the 18-inch bed being split, one-half being turned each way. The furrow slice is then raked with a tined hoe, to pull out the bulbs. We are informed that since the war the Netherlands also has resorted to a 10-inch plow for digging, as in planting. There is no doubt that narcissi, especially the larger sizes, can be successfully harvested by machinery. In the department's operations a potato digger was employed one year, with rather poor success, though the writers do not feel satisfied that it received a thorough trial. The operation of planting unquestionably will have to be so adjusted as to permit digging by machinery in commercial operations.

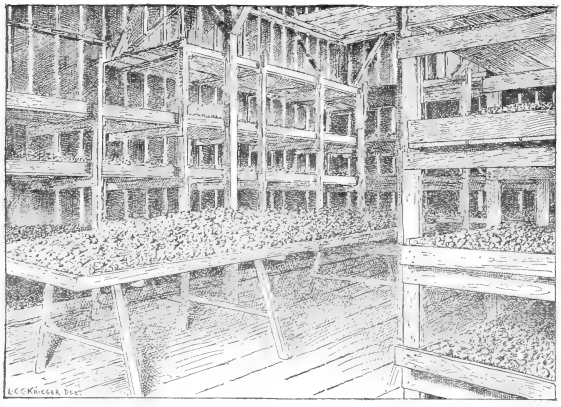

FIG. 9.—Temporary storage of narcissus bulbs in an old barn.

Various suggestions have been made, but thus far experience has approved no process of harvesting bulbs with machines. It is understood, of course, that the use of machinery in digging will necessarily change the method of planting, and virtually the entire scheme of operation. Both stationary and tractor engines have been suggested for power and a potato digger and plow operated by horses have been tried, but thus far nothing has been definitely decided for or against any power method.

STORING AND CURING.

Bulbs are stored and cured in specially constructed houses arranged with a view of getting the maximum of ventilation. The buildings are usually large and roomy, with doors (preferably in part of glass) reaching from ceiling to floor and occupying half of their walls. The interior arrangement of these houses varies. Sometimes they are equipped with stationary shelves a foot or more apart and about 3 to 4 feet wide, extending from floor to ceiling, with narrow alleyways between. (Fig. 9.) In other cases a stationary framework is built to receive removable trays. Occasionally this framework is constructed in units and is movable. Nurseries at Eureka,

Calif., are making their trays 3 by 9 feet and nesting them with the view eventually of handling by machinery a nest of 10 or more of these trays holding 3 bushels each. The Department of Agriculture has used both methods and prefers the tray which in the past has been 4 feet square. It is rather inclined to a 3-foot square, or possibly a 3 by 4 foot tray, for its purpose of handling a large number of varieties in moderate quantities. A 1-man tray may serve its experimental purposes better than one adapted to the handling of large quantities of fewer varieties.

The three classes of bulbs—tulips, narcissi, and hyacinths—require different conditions for curing. They are consequently best handled in different compartments of the bulb house. The treatment which each class receives with reference to ventilation will vary not only with the class, but also with the general atmospheric condition of the region in which the bulbs are grown. Curing under seacoast conditions will require very different handling of the ventilation from that 25 or even 10 miles inland. So variable and uncertain is this factor that experience under a particular environment is necessary before directions, except of the most general character, can be given. Experiences in handling tulips upon the grounds of the Department of Agriculture on Bellingham Bay and on those of private individuals in the Los Angeles region illustrate this fact. It is not at all unusual with us in a wet season to have small tulip bulbs on the shelves of the bulb house start to mold when only 2 to 3 inches deep. On the other hand, a grower near Los Angeles cured his tulips last year in burlap sacks. The bulbs were placed as dug in sacks about three-fourths full and tied as though filled. These packages were flattened out on the floor of the storehouse and turned over two or three times while drying. Such handling would be disastrous under the humid conditions at Bellingham.

Tulips go on the bulb-house shelves or trays as soon as they are dug, and always in thin layers. They should dry slowly. At Bellingham they are seldom dry enough to clean in less than two weeks, and it is quite possible that three weeks is the proper time for this process. During this period the bulbs should be kept well aerated, but free from draughts of air or wind and preferably not exposed to too strong light. When dry, the cleaning may begin and the bulbs returned to the shelves, but in deeper layers. After this, it should be the grower's care to keep the bulbs from drying too much, on the one hand, or molding, on the other. Much less air is necessary than during the drying process, and the light should be strictly subdued. In other words, the bulb house must be so controlled that the bulbs will not dry out too rapidly or be exposed to draughts or to too strong light. Any of these conditions will cause the bulb

coats to split. A dry, cool basement or half basement would seem to be an ideal place for such storage, but in a region adapted to bulb culture any building in which the ventilation is under good control will answer the purpose. In any location in such a building, except possibly close to the roof, where the temperature gets too high, bulbs can be cured successfully. After being cleaned the bulbs remain on the shelves in the bulb house until planting begins or until they are packed and sent to market. Sometimes the bulbs have been packed immediately after cleaning them, but it is better to leave them on the shelves and to box or sack the merchantable ones just before shipment is to take place. At times, when it is impossible to control light and air in the bulb house on account of being obliged to put tulips, narcissi, and hyacinths in the same compartment, it may be possible to cover the bulbs on the shelves with wheat chaff or buckwheat hulls. They keep very well in this way. Sometimes the shelves may be covered with burlap, or burlap curtains may be hung in front of the shelves.

FIG. 10.—Dug bulbs curing under litter from the beds.

Narcissus bulbs require less care in their handling than those of the tulip, but it is a very easy matter to injure them, too. When dug they are usually thrown into windrows in the field. In the absence of sun they can remain there for several days without injury. It has been the practice at Bellingham to let the larger bulbs have a few hours of sun, but in the Virginia bulb region it is said that two hours of exposure to the sun at midday are very likely to ruin many varieties. In the Netherlands it is a common practice to cover the windrows of bulbs with a thin layer of sand. We usually cover them with the litter hoed off the beds before digging. (Fig. 10.) When the bulbs are finally placed upon the shelves they may be piled thicker than tulips, but the thickness of the pile should be governed by the moisture content of the bulbs. They will withstand more aeration than tulips. It is for this reason advisable not to handle the two kinds of bulbs in the same compartment of the bulb house.

In practice, the curing, handling, and drying of narcissus bulbs are very likely to be done on a makeshift basis. In other words,

tulips and hyacinths receive the best care and attention, while narcissi take the space that is left. At Bellingham it has been the practice to cure and store these bulbs in an open shed, a purely temporary structure, wherein the protection is barely enough to keep off sun and rain. Indeed, at times, owing to lack of space, even tulips have been cured under similar conditions with fairly good success, but after cleaning they have always been stored in a more careful manner. The conditions at Bellingham are possibly rather favorable to such a makeshift treatment. A dirt floor constantly moist and the influence of the near-by coast tend to mitigate the evil effect of too rapid drying.

Hyacinths are allowed to remain in the windrow but a short time after digging, at most a day, and the small sizes not at all. The larger bulbs are well coated and protected with more or less dirt, so that in our situation they are not injured by a few hours' sun. They may be brushed lightly with a rough broom in the windrow and then put on the bulb-house shelves to dry. Experience shows that they need the airiest position in the bulb house, and on this account they should not here be stored or cured in open sheds with a dirt floor, though in many situations having a drier atmosphere such sheds might be sufficiently dry. As with tulips and narcissi, the aeration of the bulb house must be much more complete during the early stages of storing and curing hyacinths, on account of the large amount of superflous moisture. After two or three weeks in storage less air is necessary, but hyacinths require better aeration during their entire period of dormancy than the other two groups. The hyacinth is not only subject to molds in storage, like the other bulbs, but is prone to succumb much more quickly to storage rots, which are less prevalent when the bulbs are kept dry.

The temperature of the storage room must necessarily be variable and bear a direct relation to moisture conditions. It is probable that the protection of an ordinarily constructed house properly controlled as to ventilation will afford suitable storage conditions in any region where bulbs can be successfully grown. A stuffy, heated condition close to the roof, however, would be detrimental, and the opposite extreme of dampness in a basement, half basement, or lower floor should also be avoided. In short, a bulb storage house requires daily attention. No formula can be given for its handling. The grower must study his conditions and become sufficiently conversant with the subject to know what to do when the conditions in any portion of the house are not what they should be. The latitude in temperature permissible in storage is indicated by Dutch practices with bulbs that are habitually subjected to artificial heat in order to hasten certain processes which take place during the dormant season. A distinct

class of bulbs, based upon this artificial heating, known as "Dutch prepared," has been on the market for some years. These are nothing more than bulbs whose development has been forced by artificial heat while in storage.

Very fundamental changes take place in bulbs while they lie "dormant" on the shelves. Should one cut a large tulip bulb open through the growing point upon digging, as soon as the leaves have died down, he would probably be disappointed in not being able to find readily the flower bud; but by September 15, unless low temperatures have been maintained, the flower will have developed to half the length of the bulb, and by the first of November the flower may be actually protruding through the tip of the bulb. All this growth has taken place in storage and is of tremendous importance to the consumer, the florist, and the producer of bulbs, for future behavior is largely influenced by these changes which take place in the bulb house. The higher the temperature during storage the more rapid is the development of the flower spike; consequently, the shorter the time necessary for it to come into blossom. A long period in storage produces similar results, so that a region which is able to dig its bulbs early will have bulbs that can be forced earlier than where they mature later and are consequently dug late. This fact is well brought out in comparative forcing tests of stocks grown in the Netherlands, in Bellingham, Wash., and in Eureka, Calif. Bulbs from the last-named locality are the earliest and the Holland-grown bulbs the latest to flower. The time was when our early forcing stocks were grown almost entirely in southern France the year previous to their importation. Now earliness is brought about in Holland-grown (late-dug) bulbs by a process of forcing in storage. The indications are that, by the selection of the locality, we can produce in this country the equal of the "Dutch prepared" or French stocks without resorting to artificial processes.

This all means that to the commercial grower the temperature of his bulb house will be such as is natural in the region from July to October, coupled with proper moisture control, and that the higher the temperature the shorter the time the bulbs can be held out of the ground, for after the flower begins to push out of the bulb deterioration takes place very rapidly.

CLEANING.

As practiced in the Netherlands cleaning is one of the tedious processes of bulb culture, as it is hand labor exclusively. A great deal of it, however, can be accelerated by the aid of simple machinery. When one has but few bulbs the operation may be done by hand, but with lots of several thousand bulbs simple devices are time savers.

In the work of the Department of Agriculture at Bellingham, tulip bulbs are placed in boxes, which are moved along by the digger. No effort is made at this time to get rid of the dirt. About a bushel of the bulbs are then shaken lightly in a homemade shaker which has a quarter-inch wire-mesh bottom (see fig. 8), and the loose dirt is thus removed. After drying, the bulbs are taken from the shelves to tables and picked over by hand. This process consists in breaking the clumps of bulbs apart and removing the old scales and bases. Of late, much labor has been saved by passing the bulbs over a 5-centimeter to 7-centimeter screen before hand picking. All the smaller loose bulbs and some scales and dirt are thus eliminated. These bulblets are then passed through a blower (fanning mill), when they are ready for planting, the large bulbs and clumps (fig. 11) being the only ones worked over by hand. This simple device of sieving out the smaller sizes reduces the handwork in cleaning tulips nearly one-half. The sieves used are made of parchment, and the blower is padded with canvas to protect the bulbs. Extreme care is necessary in all of these operations lest the bulb be bruised.

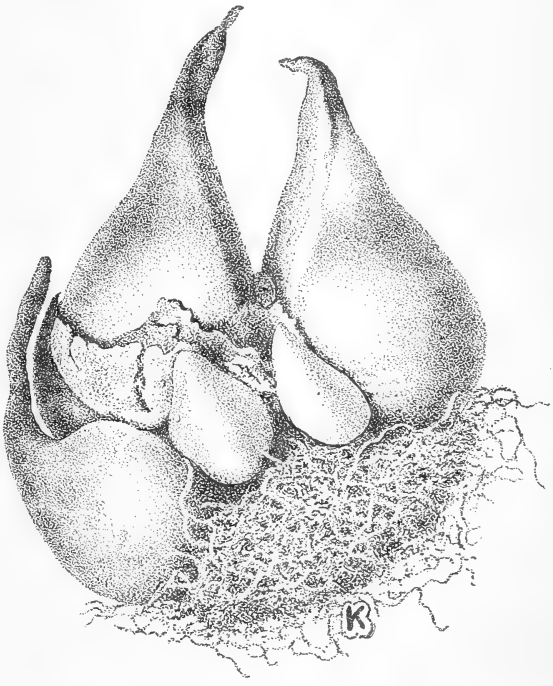

FIG. 11.—Bulbs of a Darwin tulip, showing a normal reproduction of two flowering bulbs and four smaller ones.

Narcissus bulbs, except the smaller sizes, which go into the bulb house immediately on being dug, are thrown into windrows, allowed to dry a few hours, and then covered with débris to prevent injury from the sun. Later they are sieved, like the tulips, and placed in the bulb house or in open sheds on trays or shelves. After the roots are dry the bulbs are worked over by hand to break the clumps apart. In some cases the roots are pulled off also, but it is questionable whether anything is gained in taking time for this. There was a time when the narcissus bulbs which were imported into this coun-

try were thus carefully cleaned, but this practice has been abandoned for the past two or three years.

Much time may be saved in the handling of narcissus bulbs by a little judicious planning based on the characteristics of each variety. As an example, when the bulbs of the bicolor Empress are on the cleaning tables, the easiest way to handle them is to break off and throw to one side, by hand of course, the increase, leaving the large bulbs on the table to be handled later with a shovel. With bicolor Victoria, however, where there is likely to be a large number of small bulblets, the easiest way is to pick out the large bulbs by hand and leave the small ones on the tables, to be shoveled up later and put through a blower to take out old scales and other extraneous matter. In the same way, the characteristics of the different varieties must be taken into consideration in handling the bulbs expeditiously. This is as true of tulips as of narcissi. The cleaning of the Cardinal's Hat variety should be done very differently from the Proserpine or Double Early Titian.

Hyacinths when dried are gone over carefully by hand, mainly for the purpose of culling rather than cleaning and separating them, for there is no splitting in the ordinary propagation of these bulbs. The main process of this kind occurs the first year, when the bulblets are separated from the mother-bulb clump. Often the older bulbs are left to lie in the rows for a day and then are swept with a broom before being put on the shelves. The smaller sizes, however, go directly to the bulb-house shelves, like tulips. The most difficult job of cleaning in the case of the hyacinth occurs the first autumn after propagation. At this time the bulblets come out of the ground in a clump interlaid with the old bulb scales, which still hold together more or less tightly. Usually the separation of this clump is done entirely by hand, each bulblet being picked out individually. This work can be very much simplified. The clumps must be broken up by hand, though it is not necessary to pick up the bulblets individually; but after the separation the whole mass can be put through a good blower (a fanning mill properly padded), when the stock will be rendered ready to plant. After the first year the work on the bulbs in the bulb house need consist of only a "pawing over" the shelves to pick out imperfect and diseased and rotted bulbs.

SIZING.

The Dutch grower, with high-priced land and low-priced labor, probably sizes his bulbs closer than the commercial grower in this country ever will. In the work of the Department of Agriculture the sizing has been rather closely done also, and, indeed, the Dutch methods have been employed in greater part with most of our work.

The sizes of bulbs as employed in the descriptions of commercial varieties are likely to be confusing to an American, for two reasons: (1) The metric system is used, and (2) the listings are for bulb circumference instead of diameters, as practiced with freesias in California. Since all business is done on this basis the prospective bulb grower must accustom himself to these terms. Indeed, the matter is not really complicated. The sizes of foreign-grown bulbs are always given in centimeters, abbreviated to "cm." To translate the centimeter into inches one needs only to divide by $2\frac{1}{2}$. This gives the circumference in inches. If one wishes to arrive at the diameter, a further division by 3 will give the approximate result. For instance, a 15 cm. bulb will have a circumference of 6 and a diameter of 2 inches.

The sizes of bulbs as used in commercial culture vary with each grower, and even may vary from year to year with the same grower, depending upon the land available, the fertility of soil, and other factors. In short, his grades are matters of size, and size is a matter largely of convenience and varies with fertility, age, variety, etc.

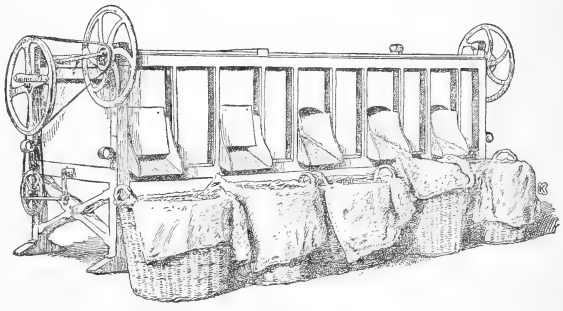

FIG. 12.—A bulb sizer used extensively in the Netherlands.

In the work of the Department of Agriculture approximate sizes have been adopted. These relate entirely to the growing end of the business and do not enter into commerce. The sizing thus far has been done mainly by the conventional circular nesting sieves of the Netherlands. These have parchment screens and are operated by being shaken in the hand or, when nested, in a hand shaker, several sizes then being sorted at once. This method works well for small quantities of bulbs. For large quantities other forms of machines are in use. One recently constructed is a revolving drum of parchment, its operation being not essentially different from a gravel screen. The most commonly used machine, however, consists of an oscillating plane made up of a series of sieves placed end to end with suitable chutes on either side to receive the different sizes. (Fig. 12.)

This matter of sizing machinery will require the attention of implement manufacturers, and there is little doubt that the need will be met as the occasion demands. The essentials are separating sieves, an operation that will not bruise the bulbs, and a good blower.

The parchment screens are made with perforations 3 to 24 centimeters in circumference. In the sizing of tulips we have employed

mostly the 13, 12, 10, 7, and 5 centimeter sieves, those bulbs caught by the 13-centimeter sieve being designated as size 1, those caught by a 12-centimeter sieve as size 2, etc. This gives six sizes, the last being those bulbs passing through the 5-centimeter sieve. Again, with tulips we employ another size, designated as "toppers," which are occasionally taken out by a 14-centimeter sieve. This size, however, is seldom used except when it is necessary to keep the larger bulbs of some varieties for propagation at the time the stocks are disposed of.

The separation of narcissus bulbs is accomplished by the use of the 16, 14, 12, 10, 7, and 5 centimeter sieves, the first size being the largest bulb. In the sizing of hyacinths the same sieves are used, plus an 18-centimeter sieve, which here is designated as size 1.

ADVANTAGES OF SIZING.

The sizing just specified, as stated elsewhere, is purely a matter of private concern and does not enter into commerce at all, being merely for the use of the grower. The only object served in this close sizing is to facilitate planting. It enables the grower to distribute plant material evenly over his ground, thus securing the maximum of economy. A grower will have bulbs of several sizes of one variety and, of course, will plant the smaller bulbs more thickly than the larger ones.

In practice, it is seldom that one variety is separated into as many sizes as have been listed here, but in order to illustrate more fully the use of sizing let us suppose that a variety of narcissus, for instance, has been so separated, that the land is laid off, the first bed opened, raked down, and marked, as described elsewhere. The largest sized bulbs will then be planted 7 to the row across a conventional 3-foot bed; the next size, 9 to the row, and the third size, 11 to the row. These, with us, are all planted singly, uniform distances apart, and set upright. The fourth size, or that caught by a 10-centimeter sieve, will be planted 14 to the row, but in seven clusters of two each, the bulbs in any position they happen to be. The next size will be planted similarly, three in each of seven clusters. The sixth size is again similarly placed in seven clusters of five each. The seventh, or smallest size, is planted 50 to the row, the bulbs being drilled uniformly along the 3-foot mark.

CULLING.

One of the most important operations—in reality a series of operations—in bulb culture is that of getting rid of undesirable plants. Successful bulb culture must be a constant process of selection or the reverse, elimination, for it is only by constant elimination of the undesirables that the stock can be kept up. The large amount

of handwork involved contributes directly to the possibility of doing a large part of this culling.

The time when culling can be done to best advantage is while the bulbs are in the bulb house. At this time all imperfect and questionable individuals should be ruthlessly rejected. No stock should be planted which is under suspicion of disease. On the other hand, especially while the grower is working up his stocks, it is necessary to distinguish between imperfections which will result simply in a reduced yield and those which may cause contamination. For instance, a skinned tulip bulb, even when slightly moldy, may and probably will produce perfectly healthy, although smaller, bulbs than those planted. A healthy reproduction may often occur even when there is no top growth. Consequently, it may be highly desirable often to plant bulbs which are of very bad appearance, provided they are not infested with a noxious disease or with insects. Such tulip bulbs will produce again. Narcissus bulbs affected with the narcissus fly, however, should be destroyed wherever found; but, even here, one bulb of a clump affected by the fly does not reduce in the least the value of the other bulbs.

FIG. 13.—Narcissus bulbs, showing a good propagation in the Sir Watkin variety.

This process of culling should be going on constantly. Beds should be rogued at blossoming time, weak plants should be destroyed during the growing season, and bulbs of poor quality or found to be infested should be culled out of stocks either in storage or in the field whenever and wherever detected.

PROPAGATION.

All of the classes of Dutch bulbs described in this bulletin can be propagated from seed, but this form of reproduction is used only by the breeder.

The writers prefer to plant the seed in the autumn in a well-prepared seed bed in a coldframe. The seed should be put in one-half inch deep and mulched with litter, which is removed before the growing season opens. Special care should be exercised to see that there is a constant supply of moisture, so as to prevent the seed from drying out at any time.

Tulips, narcissi, and hyacinths reproduce naturally in another way also. Upon reaching maturity the bulbs divide into two or

more (figs. 11 and 13), which are removed and grown to flowering size. The degree of splitting varies greatly, even in members of the same genus, and is modified by both cultural and handling methods. In practice, this is the commercial method of increasing the stocks of tulips and narcissi, and to some extent of hyacinths. The reproduction of the narcissus by this method will mean approximately a doubling each year. In the case of Darwin tulips about an 80 per cent increase each year may be expected, and in single early tulips a little less than this. So many factors are involved that it is very difficult to give exact figures.

While the propagation of the Roman hyacinth is essentially the same as that of the narcissus, the Dutch hyacinth is reproduced by a

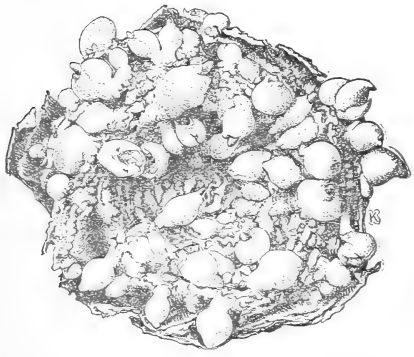

FIG. 14.—A scooped hyacinth bulb ready to be planted after in incubation period of three months in artificial heat.

FIG. 15.—A scored hyacinth bulb ready to be planted after an incubation period of three months in artificial heat.

very artificial process. It consists essentially of the destruction of the growing point of the bulb, causing the development of many growing points on the callused edges of the severed scales. Two forms of this artificial reproduction are practiced. One known as the "scooping" method (fig. 14) consists of cutting out a convex section of the bulb base, removing the basal plate entirely and making the cut parallel to its upper surface. This is done with a curved scalpel or a round-bowled spoon sharpened on the edges. The other, known as the "scoring" method (fig. 15), consists of making two to four cuts with a sharp knife across the base of the bulb, each cut being the diameter of the circular base and passing entirely through the basal plate and intersecting the other cuts in the growing point, which is destroyed.

It is a common practice to dip the cut surface of the scooped bulbs in a little air-slaked lime mixed with dry sand to hasten their drying

and prevent the growth of molds. As soon as the bulbs have been prepared by these methods they are placed in a room in which the temperature and moisture are under control. Some withhold heat for a time, simply keeping the bulbs in atmospheric temperatures; others apply a little heat immediately; but in either case a comparatively dry atmosphere is essential until the cut surfaces are callused. This takes from 10 days to two weeks. Too rapid desiccation during this period, however, must be avoided, or the center of the bulb will be injured. After callusing, the bulbs are kept in an artificial temperature and a high humidity for about three months. The temperature will vary widely, between 70° and 90° F., the object being to get a maximum development of bulblets without causing the bulbs to be forced into excessive leaf growth.

It is a common practice to bury the scored bulbs under ordinary field conditions for 10 days or two weeks and then bring them into the propagating house (fig. 16).

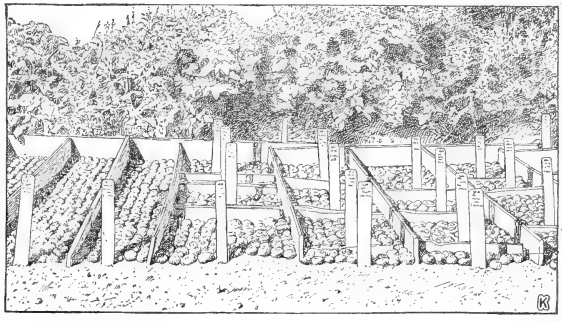

FIG. 16.—Scored hyacinth bulbs set in the open ground ready to be covered with earth preparatory to being propagated in ten days or two weeks.

At the end of the period of incubation, which will be early October, the propagated bulbs are planted in the same way as untreated bulbs.

The rate of increase will vary not only with the method of cutting the bulbs, but also with the variety. Scooping gives a comparatively large number of uniform small bulblets, while the scored method produces a smaller number of bulblets much less uniform in size but much larger. The former method is much more favored on account of the more uniform progeny, but it requires a longer time to bring the bulblets to maturity. In practice, all bulbs with perfect round bases are scooped, while those of such a character that they would not hold together if the bases were cut out are scored. In scored bulbs an average of 15 bulblets would be considered satisfactory, as would 35 in scooped bulbs, but the number of bulblets may run as high as 30 with the former and 60 to 100 with the latter treatment.

One decided advantage of scooping is its usefulness in detecting diseases. By this method the base of each scale of the bulb is exposed to a clear view when the basal plate of the bulb is scooped out. If any doubt exists after this it is customary to nose the bulb also. This consists in cutting off a small portion of the tip of the bulb as well, thus

exposing the live tissue of both ends of many of the layers. This gives a very effective check on both yellows and nematodes, the causes of the two serious maladies of these bulbs.

The building suitable for propagation is a simple affair in which heat, moisture, and ventilation are under control. At present the department's work is done in a boarded-up room in the basement of the bulb storage house, in which has been installed a hot-water heating system. Light seems to be a factor of little consequence, except that provision should be made for good artificial light for use when examining the bulbs. At present most houses in the Netherlands are constructed without glazing. We have good success also without lighting.

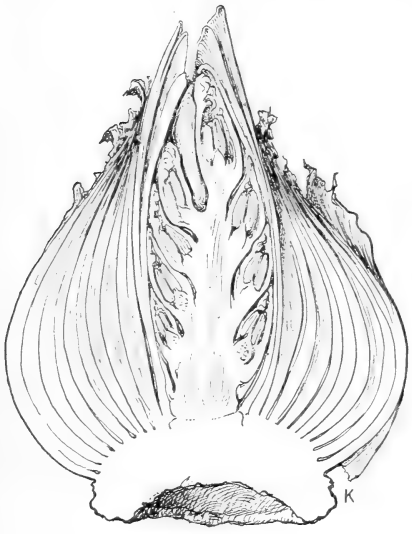

FIG. 17.—A mature hyacinth bulb cut open to show the well-developed flower spike at the time of planting.

The bulbs are supported upon trays with wire bottoms, which are arranged in racks at distances of about a foot apart. Chicken wire stretched over frames about 3 feet square answers the purpose very well. This permits the freest circulation of air around the bulbs.

DETERMINATION OF FLOWERING QUALITY.

For our purposes a bulb may be looked upon as a condensed plant which contains the evidence of its qualities within itself. The grower in his planting, but more especially in his selling, must be able to decide with a great deal of accuracy just what bulbs will flower the succeeding year. This ability is gained very largely by experience, but certain indications can be learned in the abstract.

The bulbs of the tulip, narcissus, and hyacinth have within them, perfectly formed, the flower spike for the next year's blossoms, and by the sacrifice of a few bulbs one can get a very good idea of the quality of the bulbs before they are planted.

Hyacinth bulbs are utilized for ornamentation from about 12 centimeters upward, the miniatures being usually about this size. They will flower at a much smaller size, but the number of bells will be progressively more numerous and larger as the bulb increases in growth. (Fig. 17.)

In the case of the narcissus the varieties are so variable in the size of the bulb that for the uninitiated the safest plan is always to

dissect a few bulbs. A single case will illustrate the difference in behavior. In bicolor Victoria at Bellingham in 1917 an 11-centimeter bulb was required to insure flowering the next season. Below this, three or four sizes could be separated with ease. In the Sir Watkin variety many bulbs passing through a 7-centimeter sieve would flower. There is little difference in the size of the full-grown bulbs of these two varieties, although they are very different in appearance.

The tulip, on the other hand, bears indications of future performance on its exterior. Besides the size indication, there are still others. In the department's work tulip bulbs caught by a 13-centimeter sieve have been recognized as the first commercial size and those caught by a 12-centimeter sieve as the second size. Both of these are flowering sizes and merchantable bulbs. Beyond these, there is still another size taken out by a 14-centimeter sieve, which is designated "toppers." This class the commercial grower usually should not sell but use as propagating stock, for it is here that he gets his strong and numerous progenies, and by using these toppers the grower is constantly conducting a selection of value. It is not to be understood that sizes smaller than 12 centimeters will not flower. Far from it, for bulbs as small as 8 centimeters in size could be picked out which will flower well, especially of such varieties as the Artus and the Sir Thomas Moore.

It is to be taken for granted that bulbs of the same size in the same variety will have practically the same flowering qualities, especially if produced under the same conditions. If, then, when a certain size of bulbs has been segregated it is found that some of them flowered the current year the assumption that all will flower the next year is justified. The bulb of every tulip which flowered the current year bears the evidence of it on its front side. If the base of the old flower stalk is not present, a groove marking its position is always discernible.

The bulb which will flower next year but which did not flower the current season can always be recognized by its more round appearance and long neck. Previous to flowering the bulb of a tulip produces a single but very strong leaf, the base of which is continuous with the outer coat of the bulb. A portion of this leaf base persists, forming the long neck.

A word of caution is necessary regarding attempts to determine the flowering quality of bulbs by cutting them open. Here, the consumer of bulbs has a decided advantage over the producer. As has been stated, the flower bud develops wonderfully in storage. The uninitiated may arrive at an entirely erroneous conclusion if he dissects them even late in the season when they have been held at a low temperature, but under ordinary conditions there should be no difficulty in finding the flower at planting time.

PACKING BULBS.

Bulbs in large bulk are prone to sweat and are easily bruised and mashed against the sides of the containers. For these reasons it is necessary to make shipments in some fine packing material that will sift in between the bulbs. Several substances are employed for the purpose, but grain chaff is most commonly used. Buckwheat hulls are preferred to all other materials, and rice chaff is a close second. Wheat chaff and chopped straw, while usable for a moderate time, are inclined to absorb moisture under moist atmospheric conditions. Sawdust has at times been employed, but has not always proved satisfactory. It is better when old and weathered, especially if free from turpentine and thoroughly dry. Redwood sawdust would probably be much better than other kinds, but the writers know of no experience with it. In some instances peat and finely broken up sphagnum have been employed.

Tulip bulbs are commonly packed in paper bags containing about 250 and the requisite quantity of hulls and then are shipped in crates holding 2,000 to 5,000 bulbs. Hyacinths are handled in much the same way as tulips, and so also are many varieties of narcissus, but the commoner, hardier varieties of the latter are more often forwarded in slatted crates holding 2,000 to 5,000 bulbs or more, with no packing materials. Sometimes hyacinths are forwarded in the same way.

Since 1917 the shipping of bulbs from the Netherlands has been attended with many difficulties, and they have arrived in all sorts of conditions. Probably owing to the difficulty of securing packing materials, but little was used. Hundreds of cases were a complete loss, and the commoner narcissus, which is usually shipped without packing, appeared to suffer about as much as the tulips and hyacinths. Indeed, tulips, mostly without packing material, have come through in the past two years in good condition. Much depends upon the position of the cases in the holds of the vessels and the length of time in transit. A large unaerated package is dangerous with any bulbs, since some heating is bound to occur; consequently, root action starts and very soon decomposition sets in.

SHIPPING BULBS.

The experience of the Department of Agriculture in the shipment of the bulbs of both the tulip and narcissus has been uniformly satisfactory. The latter have been shipped in citrus crates without packing. Tulips were put up one year in cloth sacks packed with buckwheat hulls, about 250 to the sack, and crated in slatted crates holding about 20 of the sacks. The past season 125,000 tulips were put up loose in buckwheat hulls in tight wooden boxes holding about

1,000 bulbs each. The stocks were well cured and came through by the northern route from Bellingham, Wash., to Washington, D. C., in perfect condition. Some of them were left in the boxes for two months, but at that time the packing material was slightly discolored, showing that this was about the limit of their endurance in these tight packages. They would not stand it as long, of course, by the southern route. The citrus crate for narcissi is satisfactory, provided there is no handling en route. Where there is any handling or shifting of the load it is too light. In car lots with little handling, however, the package is ideal, as the crate insures sufficient aeration.

BULB GROWING FOR PLEASURE.

Little need be said regarding bulb growing for pleasure, for the subject is a popular one and it has been covered so often and so well that little can be added. Naturally the purchaser of bulbs in a small way turns to the catalogues of some reputable seedsman who imports in large quantities for each autumn's distribution. Long experience has crystallized the cultural directions given in these publications. Some firms issue general directions covering all classes of bulbs, which are most valuable compendiums of information. Besides these there are plenty of publications which treat the subject exhaustively. (See page 47.)

OUT-OF-DOOR CULTURE.

In out-of-door decoration the average man uses bulbs in quantities of dozens or hundreds, planting them in formal beds or placing them carelessly in clumps, in borders among shrubbery, etc., where the result is more pleasing than in formal arrangements unless the beds are extensive enough to give a mass effect. An endless variety of effects is obtainable, depending upon individual taste, the disposition of other plantings, the configuration of the land, the exposure, and many other factors. Most landscape artists advise distributing bulbs in clumps of a half dozen to a thousand or more, depending upon the size of the grounds and the effect desired. A maxim that can always be kept in mind is that there is always the danger of not planting enough and seldom of planting too many.

To simplify directions, it is safe to cover the bulbs of the narcissus, tulip, and hyacinth 3 to 4 inches to the top of the bulb and to mulch all of them, except tulips on humid coasts where the fire disease is likely to be prevalent. Here, even, the flowers of tulips should be cut off before the petals drop, and clean culture should be practiced.

The naturalizing of the narcissus in grassy places and among shrubbery, etc., is an exceedingly attractive venture, many varieties

succeeding admirably when handled in this way. The bulbs are set with a dibble, trowel, or mattock. Usually, if time permits, it is better to remove the sod and give the ground a good digging, and, if naturally poor, fertilizer deeply incorporated is added. Regarding fertility it may be said that good garden soil is well adapted to the narcissus, but one will commonly succeed better in lean soil than with one loaded up with manures. Under the latter condition bulbs are likely to decay, even though the manure may be what is commonly termed "well rotted." We in this country have not yet acquired the habit of spading our ground two spades deep, as they do in foreign countries, thus putting our manure 3 to 6 inches below the bulbs. This kind of treatment on lean soil would furnish ideal conditions for the longevity of narcissus bulbs.

Narcissus beds and borders will usually improve if left alone until about the third or fourth year and then will deteriorate gradually. In grass where they have greater competition with other vegetation the multiplication is not so rapid and the crowding of the progeny is longer deferred, and if the variety is well adapted to this treatment it does not occur at all. Crowding can also be delayed by planting bulbs of the smallest size that will flower. The commercial bulbs of the second size are very suitable, but under no condition should double-nosed bulbs be bought if intended for permanent plantings. The narcissus in grassy places must be left undisturbed each year until the foliage begins to turn color well in the first half of June, then mowing can take place. The grass will have headed out by this time, and it will be necessary to go over it with a sharp scythe before the mower will do good work.

Better success usually will be had with tulips and hyacinths if they are lifted each year at the time the foliage matures. If second or third sized bulbs are planted, however, they will give good results the second year and will be satisfactory even the third year, while occasionally they are reported as successful even longer than that. Usually, however, tulips and hyacinths should be lifted each year. With the tulips, as with lilies and crocuses, there is the added danger from mice, which are very fond of the bulbs and destroy quantities of them when left semipermanently. There is much less danger from this source when the ground is thoroughly dug, thus destroying the runways of the mice in the autumn, and the bulbs are dug again in June.

In formal beds it is usually necessary to remove the bulb crop after flowering, in order that other bedding plants may be inserted. Commonly the bulbs are rooted out and thrown away, but this practice is simply another wasteful American habit that should be discontinued. The bulbs should be carefully lifted with as little injury as possible to roots and leaves and heeled in in some good situation,

to continue their development until digging time. If the job is carefully done the resultant bulbs will be but little inferior the next year, while in regions adapted to the production of bulbs if given a year of proper treatment they will entirely recover.

It is often possible and desirable to use carpeting plants, such as pansies, arabis, and phlox, to add to the mass of color or to prolong

FIG. 18.—A pot of hyacinths showing the right kind of root development at the time they are brought into full heat.

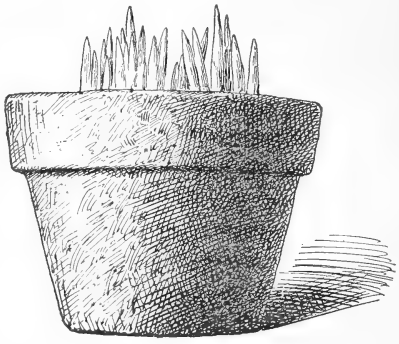

FIG. 19.—A pot of crocuses showing the time they are brought under forcing right kind of top development at the conditions.

the season, when the bulbs may be allowed to ripen in place and be lifted, and still later bedding plants may be put in. If the bulbs are set deep it is quite possible to spade or fork the ground shallowly without disturbing the bulbs and to grow any shallow-rooted crop for ornament or profit. We have known cowpeas to be planted to improve the soil and keep down weeds. These can be put in between the plants after the flowers have faded.

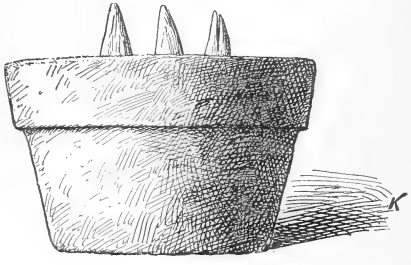

FIG. 20.—A pot of hyacinths showing a minimum of top development at the time they are taken out of the heeling ground.

INDOOR CULTURE.

While the florist successfully forces millions of narcissi, tulips, and hyacinths each season to supply the cut-flower market, the housewife fails as often as she succeeds with bulbs in the house. If, however, a proper selection of bulbs is made and certain requirements obtain, which are possibly more easily stated than found in an ordinary home, success will be assured. There are three conditions to be met. The first is to root the bulbs well before bringing them into heat (figs. 18, 19, and 20); the second, to keep the temperature down;

and the third, to keep the atmosphere moist. A little experience will enable one to meet the first condition, but our American homes are usually both too hot and too dry for the best growth of bulbs. The heat requirement can be met by selecting, preferably, an east window away from radiators or heating pipes; by covering the soil in the pots with either commercial moss or living moss from the woods greater evaporation will be induced. Avoid haste to get the flowers into blossom. Indeed, very good advice to one without experience is not to attempt to bring forced bulbs into flower earlier than the middle or, better, the last of February. As experience is gained the time can be shortened. Another good piece of advice is to give the bulbs not less than eight weeks for rooting and then to bring them into a cool cellar and introduce them to heat gradually.

Good garden soil will generally be used by the housewife for pots containing bulbs. Well-rotted manure and sand or decayed turfy loam and a little bone meal may be profitably employed if the garden soil is poor. It should be borne in mind, though, that the three conditions just specified are of even greater importance for the flowering of the bulbs than an abundance of plant food, which is of more service in building up the bulbs for the succeeding year's performance.

After the bulbs are potted they are usually buried out of doors or covered with earth, litter, ashes, etc., for a period of 8 or, preferably, 10 weeks, where they will be kept cool and moist and prevented from freezing. When the roots are sufficiently developed they are brought into a cool cellar for 10 days or two weeks and then into the living room, thus coming into heat gradually.

In writing directions for amateur bulb growers it is customary to insist on good drainage in the pot culture of bulbs in earth and then in the same breath to advise growing them in water without any drainage. This latter method is successful with many varieties. To assist in keeping the bulbs in place in bowls in water without drainage, gravel, pebbles, coal, or sphagnum moss are used, and it is desirable to add charcoal and crushed oyster shells or a little coarsely ground bone. After the roots begin to form, the bowl is easily inverted by holding the hand under it to drain out the water. This change of water should take place weekly at least. The same precautions are necessary to have the bulbs well rooted before they are brought into heat. The rooting can take place in a cool dark cellar, attic, or any other suitable and convenient situation. The plants most commonly grown in this way are the Chinese sacred lily, Paperwhite narcissus, and hyacinths, although many varieties of tulips and species of other genera succeed. It takes more experience and care to force tulips than varieties of the other two genera.

The commercial forcing of bulbous stocks need not be considered here, for the grower will refer to the columns of the trade papers, where special departments in charge of experts keep growers informed of the most approved methods of handling bulbs, based upon long experience.

MISCELLANEOUS BULBS.

Besides tulips, narcissi, and hyacinths, scores of other bulbous stocks are offered for sale as Dutch bulbs. They are of easy and profitable culture and can be readily grown by methods similar to those employed with the others. Importers and seedsmen handle some or all of them each autumn, and some of the varieties are within the reach of all. Some of these groups deserve a bulletin to themselves. All of them can be produced in this country. Of those which are especially easy of culture the following may be mentioned: Chionodoxa (glory-of-the-snow); eranthis (winter aconite); crocus; anthericum (St. Bernard's-lily and St. Bruno's-lily); galanthus (snowdrop); Spanish, English, Dutch, and oncocyclus iris; Helleborus (Christmas and Lenten roses); montbretia; muscari (grape hyacinths); scilla; camassia; leucojum (snowflake); puschkinia; triteleia; ornithogalum (star of Bethlehem).

BULB PESTS.

During the past 10 years the Department of Agriculture has imported Dutch bulbs annually. While an effort has constantly been made to get clean stocks, there has been no way of compelling compliance with its injunctions in this respect. So far as can be determined the stocks secured have been no better than the ordinary commercial importations. It is believed, therefore, that we have had a good chance to get all the maladies to which bulbs are heir. This brief statement given here relates only to those maladies with which we have had to deal.

INSECTS.

For years the most talked-of bulb pest has been the narcissus fly (*Merodon equestris*). This insect can be detected late in autumn by the "feel" of the bulb, the affected bulb being lighter in weight than the healthy ones and soft. If squeezed between the thumb and forefinger the larva, or maggot, half an inch in length and a trifle less than one-fourth inch in diameter, will commonly be forced out of the neck. Usually but one maggot is in a bulb. If late planting occurs there is an opportunity at that time to pick the bulbs over and destroy those affected. Again, in early spring, as the plants are coming through the soil and up to the time they are 4 or 5 inches high,

affected bulbs can be distinguished with a considerable degree of certainty. Weak plants or those failing to come at that season can be dug out and destroyed. This is not a difficult task, and at this time a few days spent in going over the beds will pay big dividends. The time for doing this work, however, is short, as the larva leaves the bulb for the ground shortly after the plants come up. This method of detection of these flies is applicable only when annual lifting is practiced.

Another common insect, which inhabits not only the narcissus but tulips commonly and hyacinths and scillas less frequently, is the lesser narcissus fly (*Eumeris strigatus*). In digging the weak bulbs in the spring, particularly if they contain bulbs decaying from any cause, the larva, or maggot, of this insect is likely to be more prevalent than that of the other. It is a small yellowish white maggot, somewhat larger than that of the ordinary house fly, and several to a score or more may be found in a single bulb. When first encountered this discovery is likely to create great alarm, but it is questionable whether this fly really does injury. The evidence in the literature from British sources seems to indicate that the insect is saprophytic and follows when the bulb dies and decays. One caging made at Bellingham seems to substantiate this view, since the insects failed to attack healthy bulbs.

FIRE DISEASE OF THE TULIP.

The tulip with us has been remarkably free from serious pests. But one disease of consequence has appeared. This is the fire disease, caused by a mold (*Botrytis parasitica*). This ubiquitous organism is always with us at Bellingham, and no doubt some injury is done by it. It is more prevalent upon the Darwins than any other variety, their leaves and petals being nearly always affected to some extent, but never very seriously so far as the general variety is concerned, although we have been alarmed some seasons. The season of 1916 was no exception, nor was that of 1917, but the same stock which was affected both years at Bellingham was unaffected when grown in the District of Columbia in 1917 and was reported without infestation at Eureka, Calif.

We are now on the immediate bay shore and are of the opinion that 3 miles back from the coast we will suffer less. Humid conditions and the presence of decaying organic matter, such as fallen petals, contribute to the development of the mold. It is claimed that it is for this reason that the bulb growers on the other side of the Atlantic are loath to permit any litter on their tulip beds, although they use it very freely on narcissi and hyacinths. Hail injures the leaves and assists in inoculating the plants. In the District of

Columbia a planting of 400 bulbs was heavily mulched, and this mulch was left on in the spring. Still no fire disease was discovered on the plants and no evidence of the organism noted except in the case of skinned bulbs, upon which a few of the black sclerotia, which carry the organism over the dormant season, were found. This was the report in spite of the fact that a test was made with over 100 bulbs in bad condition on account of being skinned and bruised. These bulbs were produced at Bellingham and showed considerable fire disease.

DISEASES OF HYACINTHS.

The hyacinth is troubled with enemies more than the other two groups. The most serious trouble thus far has been the yellows, or "new disease," which has been investigated by Wakker[1] and by Smith.[2] This is detected in the bulb by a softening when far advanced. If a bit of the nose of the bulb is cut off, the diseased condition can be detected by the yellow discoloration appearing in rings, segments of rings, or dots. It is a common practice with bulb growers to "nose" all bulbs planted, in order to detect this disease. Our experience, however, shows that this practice leads to very serious complications unless done with extreme care, so that we are now decidedly of the opinion that it may be a wiser plan to cull carefully without "nosing" and depend on taking out diseased plants during the growing season. At that time the disease can be detected by the water-soaked appearance of the plant and in advanced stages by the wilting down of the leaves. Great care should be exercised to cull out plants in the incipient stages of the disease in order to prevent the spread of infection. The Dutch grower uses for the removal of diseased plants a strong galvanized-iron tube 6 inches in diameter and 2 feet long, like a giant cookie cutter. This is inserted in the ground and a plug of earth, including the diseased bulb, is removed and destroyed. This "snotkoker" we have not thus far been able to use, on account of the greater density of our soils.

Stock as free as possible from this disease should be secured for propagation. It is not impossible, however, to clean up slightly infected stocks, provided the effort is intelligent and persistent. This cleaning has actually been accomplished upon our grounds by the process of culling and selection previously mentioned. Every step in the process of hyacinth culture should be carefully guarded, in order to prevent the spread of this disease.

[1] Wakker, J. H. Contributions à la pathologie végétale. *In* Arch. Néerland. Sci. Exact. et Nat. t. 23, p. 18–20. 1889.

[2] Smith, Erwin F. Wakker's hyacinth germ. U. S. Dept. Agr., Div. Veg. Phys. and Path., Bul. 26, 45 pages, 6 fig., 1 col. pl. 1901.

Another trouble to be feared on hyacinths is the "old disease" of the Netherlands. This also exhibits itself in rings, but they are dark. This also should be guarded against and culled out, as in the case of the yellows. In the growing plant this disease shows itself in the leaves in much the same way, but the water-soaked area is much more easily distinguished by the darker discoloration of the tissues of the leaf. This disease is caused by the eelworm (*Tylenchus dipsaci*). The organism can be seen on an examination under a low-power microscope of a portion of the tissue from the edge of the infestation macerated in water. The eelworm seen with the naked eye, commonly present, is a very different thing, which should not cause alarm.

THE MOSAIC DISEASE.

All the classes of bulbs treated in this bulletin are more or less affected with the mosaic disease, which in all cases reduces the vitality and stature of the plants. The Sir Watkin and Princeps Maximus narcissi and, of course, the broken tulips exhibit the condition most. Our work has demonstrated that this disease can be reduced if not quite gotten out of narcissi by selection. It is well known that it does not appear in seedlings. This is the "gray disease" of the Netherlands. It is carefully culled out of both narcissi and hyacinths, but when it comes to tulips the case is very different. Here the breaking, as it is called, gives a very spectacular and commonly pleasing effect in the flowers that is greatly admired. Consequently, nearly as long lists of broken tulips as of breeders have been segregated and established as commercial varieties. Their use and study are more extensive in the British Isles than elsewhere.

It would probably be much wiser for the commercial grower in this country not to attempt to plant these broken tulips, for a time at least, or if he grows them to do so at a safe distance from the breeders, which will always be the main stocks, for it has been repeatedly shown that this diseased condition is communicable. This mosaic affection should be looked upon just as much as a disease in tulips as it is in other well-known plants. There exists abundant evidence of the communicability of this disease, and there are some suggestions that the aphis may be the main carrier.

THE BEST VARIETIES TO PLANT.

While there might be substantial agreement among growers as to the best varieties of hyacinths to plant, fewer would agree on lists of narcissi, and it would be difficult to find two who would agree on the same list of tulips. Any recommendations, therefore, of tulip or narcissus varieties are subject to all sorts of revisions, but may be useful to those who have had little or no experience with the

wealth of decorative material in these groups. In the preparation of any list availability must be one of the first requisites. Here, again, one is very likely to encounter great differences of opinion and conditions while we continue to be dependent, as we are, upon foreign importations. The importing florist and seedsman have to depend upon the foreign grower. The purchaser of bulbs in this country depends upon his florist. The varieties which can be found on the markets are often limited and vary from year to year. There are, however, certain standard varieties in the three groups which are nearly always obtainable, such as the now widely used and easily propagated Marie, Roi des Belges, Grand Maitre, and L'Innocence in hyacinths; Emperor, Empress, Golden Spur, and Sir Watkin in narcissi; and Chrysolora, Keizerskroon, Couleur Cardinal, Cottage Maid, Clara Butt, Faust, and Pride of Haarlem in tulips. These are all produced by the hundreds of thousands each year and the private individual will always find satisfaction in using them. The commercial grower, of course, will give his lists the most careful study and consider the demands of the trade which he intends to supply. It is more than likely that American production will for a long time limit itself to varieties for which there is a very great demand and will grow much fewer varieties than are now offered for sale in Dutch and British catalogues.

Already this specialization is evident. Although the largest producer of Dutch bulbs at the present time is handling a very long list in each group, this is confessedly experimental, the avowed intention being finally to sift out the less desirable and concentrate upon the standard varieties. Another large firm grows 60 to 80 varieties of narcissi, but their production in large quantity is confined to not more than a dozen. Another firm grows mainly two forcing varieties of narcissi and a few other forcing bulbous stocks, specializing as it were upon forcing bulbs.

VARIETIES OF NARCISSI.

Most of the lists of narcissus of any pretension are now compiled in accordance with the recommendations of the committee of the Royal Horticultural Society of England,[1] which arranged a classification into 11 divisions, the last of which is a catchall, made up mainly of botanical species. The following list, arranged according to this catalogue, is made up of varieties which stand a good chance of doing well under varying conditions. Another useful grouping not recognized by the committee of the Royal Horticultural Society but commonly found in catalogues is the Poetaz section, made up of hybrids

[1] Royal Horticultural Society. Classified List of Daffodil Names, 1914. 73 p. [London, 1914.]

between the Tazetta and Poeticus groups. These varieties are among the most desirable of the bunch-flowered forms and are represented in this list by the last three in Division VIII.

The varieties in this list are dual-purpose ones in largest part, i. e., adapted to both indoor and outdoor culture. The exceptions are the first three named under the Tazettas. These are adapted to out-of-door use in the warmer sections of the country.

FIG. 21.—The Golden Spur narcissus, a most popular trumpet daffodil.

FIG. 22.—The Glory of Leyden narcissus (trumpet daffodil).

Telamonius Plenus (Double Van Sion) will usually not give satisfaction after the first year either out of doors or indoors. In all situations where it has been tried, except on the immediate coast north of San Francisco, the North Atlantic coast, and high, cool situations elsewhere, it turns green after the first year.

I. *Long trumpets* (as long as perianth segments).—Daffodils.

(*a*) Trumpets and perianth segments the same or different shades of yellow.

Golden Spur (fig. 21).
Henry Irving.
King Alfred.
Emperor.
Glory of Leyden (fig. 22).
Obvallaris.

(*b*) Trumpets and perianth white.

Madame de Graaff.
W. P. Milner.
Albicans.
Loveliness.

(*c*) Perianth white; trumpets some shade of yellow. (Bicolor.)

Madame Plemp.
Empress (fig. 23).
Victoria.
Weardale Perfection.
Glory of Noordwijk.
Mrs. Moriand Crosfield.

II. *Incomparabilis.*—Large chalice-cupped daffodils; trumpet one-third to one-half the length of the perianth segments.

Sir Watkin (fig. 24).
Lucifer.
Autocrat.
Great Warley.
Gloria Mundi.
Gwyther.

III. *Barrii.*—Small chalice-cupped daffodils; trumpet less than one-third the length of the perianth segments.

Barrii Conspicuus (fig. 25).
Firebrand.
Seagull.
Toreador.
Mohican.

IV. *Leedsii.*—Like Incomparabilis and Barrii; but the flowers white or yellow tinted.

Fairy Queen.
Maria Magdalene de Graaff.
White Lady.
Mrs. Langtry (fig. 26).

FIG. 23.—The Empress narcissus. Experimental planting at Bellingham, Wash.

V. *Triandrus hybrids.*—Cyclamen-flowered daffodils.

Triandrus Albus (Angels' Tears).
Queen of Spain.
Agnes Harvey.

VI. *Cyclamineus hybrids.*—Yellow cyclamen-flowered daffodils.

Cyclamineus and its hybrids.

VII. *Jonquilla hybrids.*[1]—The hybrids of Narcissus Jonquilla—Jonquils.

Buttercup.
Jonquilla.
Odorous Campernelle.
Rugulosus Maximus.

VIII. *Tazetta and its hybrids.*[2]—Bunch-flowered narcissi.

Paperwhite Grandiflora.
Chinese sacred lily.
Double Roman.
Elvira (figs. 27 and 28).
Klondike.
Jaune a' Merveille.

[1] These are the only true jonquils.

[2] Commonly called "narcissi."

FIG. 24.—The Sir Watkin narcissus—the giant Welsh daffodil (Incomparabilis group).

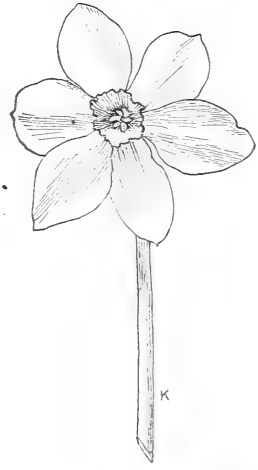

FIG. 25.—Narcissus Barrii Conspicuus (Barrii group).

FIG. 26.—The Mrs. Langtry narcissus (Leedsii group).

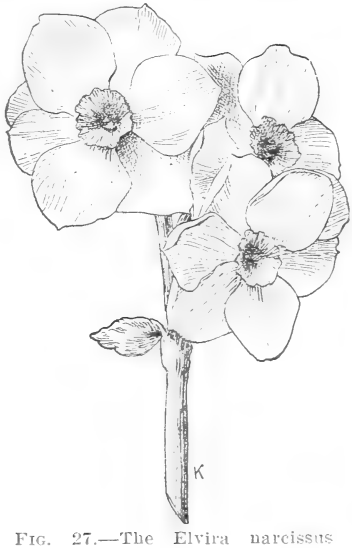

FIG. 27.—The Elvira narcissus (Poetaz group).

IX. *Poeticus varieties.*[1]—Snow-white perianth and variously colored short trumpet.

Praecox Grandiflora.
Cassandra.
Ornatus (fig. 29).
Minerva.
The Bride.

X. *Double varieties.*

Trumpets.—Telamonius Plenus (Double Van Sion) (fig. 30).
Incomparabilis.—Argent, Sulphur Phoenix (Codlins and Cream).
Primrose Phoenix.

FIG. 28.—A block of 25,000 Elvira narcissi. Experimental planting at Bellingham, Wash.

VARIETIES OF TULIPS.

The classification of the tulip is purely artificial and a complicated subject, most seriously attempted in 1917 by a committee of the Royal Horticultural Society of England.[2]

Tulips are first divided into early, late, or May flowering, which need no definition, and species which are found native. The earlies are divided into the Duc van Tholl, which are very early dwarfs, the singles, and the doubles.

The lates are divided (1) into the Cottage subsection, which is a catchall that is not definable except that its members do not belong in the other groups; (2) breeders which are self-colors; (3) broken or mosaic tulips, parrots which have laciniate floral segments; and (4) double late tulips.

[1] Commonly called "narcissi."
[2] Report of the Tulip Nomenclature Committee, Royal Hort. Soc., London. 1917.

The largest and most popular after the single earlies are the breeders.[1] The flowers are self-colored except the base. They are divided into Dutch, English, and Darwins—the Dutch with a cup-shaped flower, the English with a hemispherical flower, and the Darwins with a rectangular-based flower. The Dutch and English breeders are again subdivided into three divisions: Roses, which are pink to red in color, the ground or tissue of the petals below the epidermis being white; Bybloemen, which are purple to violet and also have a white ground; and Bizarres, which have shades of scarlet to bronze with a yellow ground.

FIG. 29.—Narcissus Poeticus Ornatus (Poeticus group).

As stated elsewhere, the broken tulips are subdivided the same as the breeders from which they are derived. Their irregular distribution of the epidermal colors superimposed upon white or yellow grounds gives very brilliant and attractive effects. None of the varieties, however, are as vigorous as the breeders from which they are derived.

FIG. 30.—The Double Van Sion narcissus. Experimental planting at Bellingham, Wash.

SECTION I.

Early flowering. (In full flower before the end of April.)

A. *Duc van Tholl.*—The earliest of all. Single dwarf, rarely exceeding 6 inches in height. May be had in a variety of colors and commonly listed as Duc van Tholl red, Duc van Tholl white, etc.

[1] The single earlies are also breeders.

B. *Single flowered.*—Early but larger than the previous group and better for dual purposes.

White.—White Hawk, Pottebakker white.

Blush-pink.—La Reine and La Reine Maxima, Cottage Maid.

Red-yellow.—Grand Duc (Keizerskroon) Hector, Duchesse de Parma.

Orange.—Fred Moore and Thomas Moore.

Scarlet and orange-scarlet.—Prince of Austria, Couleur Cardinal, Artus, Vermilion Brilliant.

Yellow.—Mon Tresor (fig. 31), Yellow Prince, Chrysolora.

C. *Double flowered.*

White.—Schoonoord, La Candeur.

Scarlet.—Vuurbaak, Imperator Rubrorum.

Orange and red.—El Toreador, Prince of Orange.

Red (edge yellow).—Tournesol.

FIG. 31.—The Mon Tresor tulip, a variety of the "Single Early" group. Experimental planting at Bellingham, Wash.

SECTION II.

Late or May flowering.

A. *Cottage varieties.*—A catchall for a miscellaneous lot of breeder varieties not belonging to the other groups of this section.

Several colors.—Ingelscombe, Gesneriana, Fulgens, Didieri, and Elegans varieties.

White.—La Candeur (Parisian White), Royal White.

Yellow.—Glare of the Garden, Golden Eagle, Parisian Yellow, Retroflexa, Yellow Perfection, Bouton d'Or, Golden Crown, Retroflexa Grandiflora.

Rosy white.—The Fawn, Isabella.

Scarlet.—La Merveille, Scarlet Mammoth.

Primrose.—Vitellina.

B. *Breeders.*—The flowers are of one color except the base.

(1) *Dutch breeders.*—Flower oval or cupped, brown, purple, or red, but sometimes bronze. Base white or yellow, but usually stained blue or green to blue-black.

(*a*) Roses (pink to red).—Charles Dickens, Crimson Beauty, Annie McGregor.

(*b*) Bybloemen (purple to violet).—Cardinal Manning, Godet Parfait, Roi de Siam, Louis XIV.

(*c*) Bizarres (scarlet, bronze, or brown).—Panorama, Louis XIV, James Watt, Turenne, Dom Pedro.

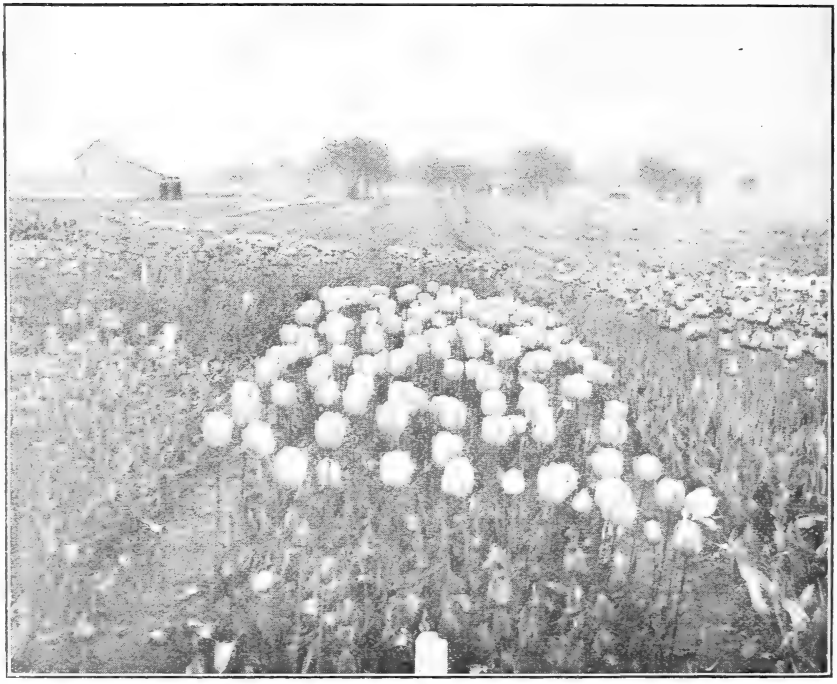

FIG. 32.—The Sieraad van Flora tulip of the "Darwin" group, and other varieties. Experimental planting at Bellingham, Wash.

(2) *English breeders.*—Flower cup shaped, forming one-half of a hollow ball when expanded, the base being white or yellow.

(*a*) Roses (rose shades with white base).—Annie McGregor, Mabel, Mrs. Barlow.

(*b*) Bybloemen (purple shades with white base).—Adonis, Elizabeth Peck, Talisman.

(*c*) Bizarres (brown shades with yellow base).—Sir Joseph Paxton, Goldfinder, Sulphur, Samuel Barlow.

(3) *Darwins.*—Lower portion of flowers rectangular; shades of purple, red, or white, never yellow or brown. Base black-blue or white or any combination.

Pale rosy.—Flamingo, White Queen, Margaret, Mrs. Cleveland.

B. *Breeders*—Continued.

(3) *Darwins*—Continued.

Rose.—Anton Roozen, Baronne de la Tonnaye, Clara Butt, Loveliness, Psyche, Massachusetts, Sieraad van Flora. (Fig. 32.)

Red.—Europe, Feu Brilliant, Harry Veitch, King George V, Farncombe Sanders, Pride of Haarlem, Prof. Francis Darwin, Prof. Rauwenhoff, Whistler.

Mauve, light lilac.—Bleu Amiable, Dream, Euterpe, Lantern, Remembrance, Rev. H. Ewbank.

Purple, dark blue.—Bleu Celeste, Frans Hals, Marconi, Mrs. Potter Palmer, Viking.

Maroon.—Faust, Black Knight, Zulu, Fra Angelico, Othello, La Tulipe Noire.

C. *Broken tulips.*—The mosaic tulips in which color is in irregular stripes and accentuated streaks in the flowers and foliage.[1]

(1) *Broken Dutch.*

(*a*) Roses (rose or cherry markings on white ground).—Admiral van Kingsberger, Comte de Vergennes, Henry VIII, Perle Brilliante.

(*b*) Bybloemen (violet or purple markings on white ground).—Dainty Maid, Imperatrice de Maroc, May Blossom.

(*c*) Bizarres (brown, red, or purple markings on yellow ground).—Chebourg, Miss Doris Diggle, Trafalgar.

(2) *Broken English.*

(*a*) Roses (rose markings on white ground).—Annie McGregor, Mabel Aglaia.

(*b*) Bybloemen (purple markings on white ground).—Adonis, Duchess of Sutherland.

(*c*) Bizarres (brown or black markings on yellow ground).—Samuel Barlow, Sir Joseph Paxton, Dr. Hardy, George Hayard, Lord Stanley.

(3) *Rembrandt* (Broken Darwins).

(*a*) Roses (rose markings on white ground).—Red Prince, Semele, Victor Hugo, Galatea.

(*b*) Bybloemen (purple markings on white ground).—François d'Amboise, Pericles, Wedding Veil, Remembrance, Gretchen.

(4) *Broken Cottage.*

(*a*) Roses (rose markings on white ground).—Striped Beauty, Zommerschoon.

(*b*) Bybloemen (purple markings on white ground).—Twilight, Union Jack.

(*c*) Bizarres (brown, red, or purple markings on yellow ground).—Chameleon, Gala Beauty, Scotia.

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[1] A similar condition is found in narcissi and hyacinths, when it is known in the Netherlands as the "gray disease." The subdivisions of the May-flowering groups are duplicated in this group. In other words, any of the self-colored tulips may become broken and are ever after weaker in constitution and require careful handling to keep up to the necessary vigor. They are consequently little cultivated, with the exception of the Rembrandts, which, owing to the excessive vigor of the Darwins, of which they are broken forms, are still vigorous enough to endure and give satisfaction. Aside from the Rembrandts, these are seldom seen in this country. In the list of varieties enumerated, therefore, little more has been done than to copy the leading varieties as given by the English Tulip Nomenclature Committee.

D. *Parrots.* Segments of flowers cut or laciniated.
Sensation, Markgraaf, Lutea Major, Admiral de Constantinople.
E. *Doubles.* Blue Flag, Mariage de ma Fille, Orange Brilliant, Yellow Rose.

SECTION III.

Species of tulips growing in the state of nature.
Clusiana, Greigii, Hageri, Praestans, Sylvestris.

VARIETIES OF HYACINTHS.

Hyacinths are listed by color in singles and doubles, the singles being much the more popular. They are offered for sale in several classes, such as miniatures and first and second sizes, which are approximately 18 and 16 cm. bulbs, respectively. Besides these, there is commonly a miniature size (about a 13-cm. bulb) offered for bedding and growing in pots.

The Dutch-Roman hyacinth is grown the last year in the south of France, where the season is earlier and the bulbs are consequently capable of being forced into blossom correspondingly earlier than Holland-grown stocks of the same varieties.

The "Dutch prepared" hyacinth is a recent invention, being the ordinary Dutch varieties grown in the Netherlands, but dug early and incubated in artificial heat for the purpose of accelerating the development of the flower buds during the dormant period. These are also capable of being forced into flower earlier. These bulbs are often "soft," due to withering under the artificial treatment, and their appearance is consequently not necessarily an index to their performance.

These early forcing varieties, especially the "Dutch prepared," often are not successful in this country, mainly owing to improper conditions for rooting. Our atmospheric and soil temperatures in late August and early September are too high to root them properly except in cool cellars.

The Roman hyacinth is also offered along with the Dutch varieties. It is early, more graceful than the stiff Dutch varieties, and is grown in southern France. It is adapted only to indoor culture except in the South, while the Dutch varieties are hardy.

The following list, considered from the standpoint of availability and performance, is suggestive. The varieties are those commonly offered for sale and, of course, the leading and most popular sorts.

Single red and rose.
Gertrude, Gigantea, Roi des Belges, General de Wet, Lady Derby.
Single white.
L'Innocence, Mr. Plimsoll, Baroness van Thuyll, Madam van der Hoop.
Single blue.
Captain Boyton, Grand Maitre, Queen of the Blues, Marie, Schotel.

Single yellow.
Yellow Hammer, King of the Yellows.
Double red and rose.
Bouquet Royal, President Roosevelt, Prince of Orange.
Double white and blush.
Bouquet Royal, Isabella, Prince of Waterloo.
Double blue.
Bloksberg, General Köhler, Van Speyk.
Double yellow.
Goethe, William III.

BULB LITERATURE.

The literature of bulbs is exceedingly varied and exhaustive, but commonly not available to the average reader. American writings are fragmentary, although they also are quite voluminous. In spite of these facts, anyone with a little effort may get in touch with abundant sources of information on the subject. There are four main sources to consult—

(1) Florist, horticultural, and agricultural papers. These are replete with writings on various phases of the subject, and every issue of many of them carries advertisements of bulb literature.

(2) Of bulb books there are many. They are exhaustive and comprehensive and written in English. A few are American, but most of them are of British origin.

(3) Florist catalogues contain succinct and pointed information regarding the handling of bulbs for decoration. Some of the larger houses issue separate leaflets and pamphlets on methods of culture. These may be had for the asking when purchasing bulbs.

(4) The florists have the columns of their trade papers, as stated on a previous page. Here are to be found the crystallized personal experiences of experts in the commercial production of florist materials.

DEFINITIONS.

Much of the information in bulb literature and even in popular catalogues is in language quite strange to the uninitiated. Like every other specialized line of endeavor, the bulb business possesses a considerable language of its own. The following definitions will assist in a better understanding of some of these expressions.

Barrii.—A group of narcissi having small chalice-cupped coronas or trumpets.

Bed.—A Dutch bulb bed is a meter wide, of any convenient length, but usually about 10 meters (about 33 feet) long.

Bicolor.—A trumpet narcissus with yellow trumpets and white perianth segments.

Bizarres.—Tulips of various shades of scarlet to brown in the breeder and broken sections, but, unlike the bybloemens, they have a yellow ground.

Blower.—A machine or contrivance for removing the loose hulls and other light material from bulbs.

Breeders.—Tulips with self-colored flowers. The color of the base of the flower is not taken into account.

Broken tulips.—Tulips in which the coloring matter is unequally distributed in both flowers and foliage.

Bulb.—A fleshy underground bud with thick succulent scales. It is an entire plant condensed into a gigantic bud.

Bulb house.—The storehouse in which bulbs are kept and handled between the time of digging and planting.

Bybloemen.—Tulips of various shades of purple to violet in the breeder and broken sections. The ground color of the petal (the color of the tissue between the epidermal layers) is white.

Centimeter.—One 1/100th of a meter, or about two-fifths of an inch.

Cleaning.—Separation of bulbs from the clumps in which they grew and the removal of dirt and chaff from them.

Corona.—The crown cup or tube of the narcissus flower.

Culling.—Removal of undesirable bulbs.

Curing.—The treatment of bulbs in storage.

Cutting.—Removing tulip and hyacinth flowers from the beds.

Daffodils.—The largest section of the genus Narcissus. It includes in common parlance all but the rush-leaved forms, or jonquils.

Darwins.—For the most part a robust May-flowering group of tulips with flowers of a rectangular form at the base.

Double Earlies.—Double-flowered early tulip varieties.

Dropper.—A stemlike growth frequent in many classes of bulbs. It grows downward some distance from the parent bulb and gives rise at its extremity to a new deeper set bulb.

Dutch bulbs.—Tulips, narcissi, and hyacinths, besides a score of other bulbs and roots which in the Netherlands are propagated for sale. They are often called Holland bulbs.

Dutch-Roman.—Hyacinths of the Dutch varieties grown the last year in the south of France.

Dutch prepared.—Dutch hyacinths dug early and subjected to artificial heat to hasten the development of the flower spike.

Fire.—An abbreviated term for the fire disease of tulips caused by the fungus *Botrytis parasitica.*

Gray disease.—The mosaic of hyacinths and narcissus.

Hyacinth.—A low, herbaceous perennial of the lily family, usually with a large spike of bell-shaped flowers terminating a short scape and a coated bulb with outer coats papery, similar to those of the narcissus or the onion.

Hyacinth, Roman.—A species distinct from the Dutch hyacinth. It is more graceful than the latter and not adapted to out-of-door culture except in the South.

Hyacinth, Dutch.—The common hyacinth.

Incomparabilis.—A group of narcissi having large chalice-cupped coronas.

Increase.—The propagated stock of bulbs of any one period.

Jonquils.—A small group of the genus Narcissus with rushlike leaves. The terms narcissus, daffodil, and jonquil are used as common names very loosely and with a great deal of confusion. Often people use the name daffodil to designate all the single-flowered forms except the rush-leaved ones and the Poeticus section. The rush-leaved forms are called jonquils and the bunch-flowered and Poeticus groups narcissi.

Leedsii.—A group of narcissi like the Incomparabilis and Barrii sections, but the flowers are white or only slightly yellowish tinted.

Marker.—A machine with a revolving drum used to lay off the boundaries and the rows of a bulb bed.

Meter.—A unit of metric measurement, 39.37 inches.

Mosaic.—A term used to designate any irregular distribution of coloring matter in leaves and floral parts of the plants.

Narcissus.—A low, herbaceous, perennial plant belonging to the amaryllis family, having narrow radical leaves, flowers with a corona or trumpet, and the outer coats dry and papery but not continuous, like that of the tulip.

Narcissus fly.—Two species of flies are conspicuous in narcissus bulbs. The large *Merodon equestris* is commonly known as the greater narcissus fly and the small *Eumerus strigatus* as the lesser narcissus fly. The first is parasitic and the second is considered saprophytic.

New disease.—The yellow disease of hyacinths caused by *Bacillus hyacinthi.*

Old disease.—A nematode disease, especially of hyacinths.

Packing material.—Buckwheat hulls, rice chaff, sawdust, etc., used in packing bulbs.

Parasite.—An organism which is able to attack and destroy live and healthy plants.

Parrots.—Tulips with cut or laciniate floral parts.

Path.—A narrow passageway of 12 to 16 inches between successive beds of bulbs.

Perianth.—The outer floral envelope of the flower.

Plat.—As here used, a land bordered by a walk, road, or ditch, or all of them combined, its width being the length of the bulb beds.

Poets' Narcissus.—A group of the genus Narcissus having a pure white perianth and variously colored short crowns.

Propagation.—The increasing of stocks of plants by any process.

Rembrandts.—Broken Darwin tulips.

Roguing.—The process of digging out and getting rid of undesirable plants or plants out of place.

Roses.—Tulips of various shades of pink to rose in the breeder and broken sections. They have a white ground (tissue between the epidermal layers of the petals).

Row.—A row in a Dutch bulb bed is a meter in length and extends across the bed. The rows are usually about 6 inches apart.

Saprophyte.—An organism which lives only on the dead tissues.

Scooping.—A method of propagating hyacinths consisting of the scooping out of the basal plate (stem) and exposing the scale edges to callousing and subsequent budding, which results in the production of bulblets.

Scoring.—A method of propagating hyacinths in which the basal plate is hacked by three or four cuts through its diameter, for the same purpose as scooping.

Shaker.—A machine designed to remove mechanically the loose dirt from bulbs.

Sieves.—Sieves are of two kinds. The shaker has a sieve through which the dirt passes and this is sometimes referred to as a sieve. The nesting circular parchment sizers are also often referred to as sieves.

Single earlies.—Single-flowered early tulip varieties.

Sizers.—These are machines employed for separating bulbs into different sizes. The separation is accomplished by means of an oscillating screen, preferably of parchment, perforated to allow the passage of objects of a definite circumference measured in centimeters (cm.). A large oscillating plane made up in

sections is employed in the machine (Vlinder) most used in the Netherlands. Simpler machines are a common circular nesting sieve, which may be used singly, or when nested three of four together, in a specially constructed hand shaker, when several sizes of bulbs may be taken out at once.

Tazetta.—A bunch-flowered narcissus; also the specific name of the original bunch-flowered species.

Trays.—Flat receptacles for storing bulbs in the bulb house.

Trumpet.—The crown, or corona, of the narcissus.

Tulip.—A low, herbaceous, perennial plant of the lily family with a scapelike, single-flowered stem from a tunicated bulb, the outer layer of which is continuous and ruptures before growth starts.

Vlinder.—See under Sizers.

Walk.—The vacant space left as a passageway between the bulb plats, which many include ditching space.

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